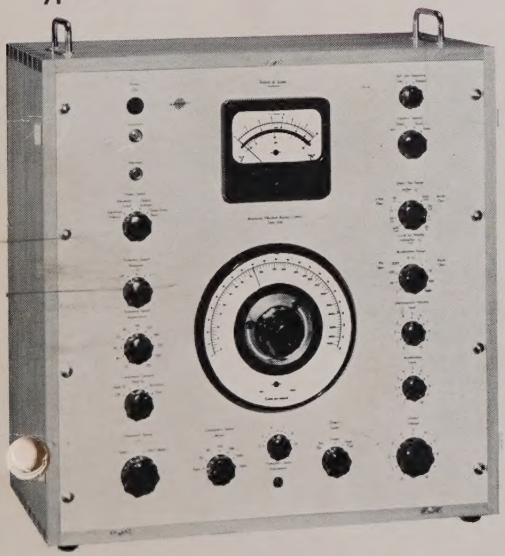
1018

INSTRUCTIONS AND APPLICATIONS

ID No. SYL 2525
– RETURN TO –
INSTRUMENT CONTROL

Automatic Vibration Exciter Control Type 1018



The Automatic Vibration Exciter Control is a specially designed signal source for the vibration testing of mechanical and electro-mechanical components in the frequency range 5 c/s to 10 kc/s.

- Accelerometers
- Acoustic Standing Wave Apparatus
- Artificial Ears
- Artificial Voices
- Audio Frequency Response Tracers
- Audio Frequency Spectrometers
- Audio Frequency Vacuum-Tube Voltmeters
- Automatic A. F. Response and Spectrum Recorders
- Automatic Vibration-Exciter Control Generators
- Band-Pass Filter Sets
- Beat Frequency Oscillators
- Complex Modulus Apparatus
- Condenser Microphones
- Deviation Bridges
- Distortion Measuring Bridges
- Frequency Analyzers
- Frequency Measuring Bridges
- Hearing Aid Test Apparatus
- Heterodyne Voltmeters
- Level Recorders
- Megohmmeters
- Microphone Accessories
- Microphone Amplifiers
- Microphone Calibration Apparatus
- Mobile Laboratories
- Noise Generators
- Noise Limit Indicators
- Pistonphones
- Polar Diagram Recorders
- Preamplifiers
- Precision Sound Level Meters
- Recording Paper
- Strain Gage Apparatus and Accessories
- Surface Roughness Meters
- Variable Frequency Rejection Filters
- VHF-Converters
- Vibration Pick-ups
- Vibration Pick-up Preamplifiers
- Wide Range Vacuum Tube Voltmeters

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BB 1018

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ID No SYL2525
– RETURN TO –
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SYLVANIA SES -- West

Automatic Vibration Exciter Control

Type 1018

Reprint july 1963

level of the table tends to increase, which would cause the output voltage from the control pick-up to increase, the input power to the vibration exciter is automatically decreased until the status quo is regained.

The time interval from the increase in vibration level (felt by the control pick-up) to the decrease in the input power to the vibration exciter is, although very small, not negligible. This time constant, or in other words "regulation speed", should be selected according to the expected Q-values of the system resonances and the scanning speed chosen for the frequency sweep, i. e. the regulation speed must be greater than the speed with which the system resonances are built up.

Regarding which of the three vibrational quantities, acceleration, velocity, or displacement, is the most important, with respect to structural damage, environmental tests show that at the lower frequencies the occurance of structural damage is most likely to be proportional to the displacement level of the vibrations, whereas at the higher frequencies the damage depends upon the acceleration level.

Vibration tests are therefore often carried cut with a constant displacement level at low frequencies, and at a constant acceleration level at higher frequencies. The exact frequency of the cross-over from constant displacement to constant acceleration operation is stated in the different vibration test specifications, e. g. MIL-E-5272 A a. o., and depends on the conditions under which the test object is supposed to operate in practice.

Introduction

Mechanical vibrations in a construction occur whenever a change in the forces applied to it takes place. This change in the applied forces can have a periodic or non-periodic character. If the change in forces, the rate of change, or the number of force cycles applied are great enough, the construction might be damaged. The purpose of vibration testing is to determine the damaging effects that vibrations have on a structure, allowing it to be re-designed to prevent such damage from taking place under normal operating conditions. The importance of vibration testing depends upon the severity of damage caused by a breakdown, and has been fully recognized in recent years.

As long as only simple structures are to be considered, it is possible to calculate the effects of vibrations. However, as the structure becomes more and more complicated and the operating conditions more and more complex and severe, the amount of calculation involved is large. In such circumstances, vibration testing may be the only practical solution to the problem of determining vibrational effects.

This is especially true of the aircraft and missile field, where not only the periodic changes in force caused by the engines, but also the forces due to air flow turbulance play an important role. Also gas turbine parts and parts or other fast running machinery are now normally subjected to vibration testing before the final design of the part is approved.

The vibration test may be carried out in different ways, of which the three most important are:—

The shock test,
The random motion test, and
The frequency sweep test.

For the design engineer the frequency sweep test is, in the vast majority of cases, the most preferable method, as the natural frequencies of the objects under test as well as their Q-values are directly measured.

The frequency sweep test is carried out by feeding a vibration exciter with a certain amount of power at a slowly changing frequency. Due to resonances in the test object and the vibration exciter system, the power necessary to vibrate the test object at a certain constant level is not, however, independent of the frequency. To keep the vibration level constant, the output from a vibration pick-up, built into the shaker or mounted on it, is used to control the input power to the vibration exciter. Normally, the control of the vibration level is made in such a way, that when the vibration

The vibration meter enables easy setting and monitoring of the vibration level in terms of inches (cm), inches/sec. (cm/sec.), or G*) depending on whether the displacement, the velocity, or the acceleration level is kept constant by the automatic level regulation.

The vibration level can be controlled in different ways:—

1. **The displacement level** of the shaker table can be kept constant, independent of frequency, or
2. **The velocity level** can be kept constant, or
3. **The acceleration level** can be kept constant, or
4. The displacement level can be kept constant below a certain pre-set cross-over frequency, above which the acceleration level is kept constant.

The desired type of operation is chosen by means of the "Function Selector" knob. Additionally it is possible to control the table motion either by means of a velocity type vibration pick-up (signal generator coil), or by means of an accelerometer according to the following table:—

Controlling Element	Velocity Gen.	Accel. Gen.
Frequency range in which the shaker *displacement* level can be kept constant.	5—2000 cps.	5—2000 cps (50—2000 cps for level range 0.01").
Frequency range in which the shaker *velocity* level can be kept constant.	5—2000 cps	—
Frequency range in which the shaker *acceleration* level can be kept constant.	10—2000 cps.	10—10000 cps
Frequency range in which *automatic cross-over* is possible.	10—500 cps.	10—500 cps

The regulation speed of the regulating amplifier is variable, providing regulation speeds of 10, 30, 100, 300, 1000 and 3000 db/sec. This regulation speed is the speed with which a sudden change in the operating conditions of the shaker table is regulated back to "normal", and is chosen by means

*) G = 981 cm/sec² = 32.2 ft/sec² = 386 inch/sec² = Acceleration of gravity.

Description

General Description of the AVEC Type 1018

The Automatic Vibration Exciter Control Type 1018 is designed as a signal source for frequency sweep vibration tests and consists basically of an oscillator, a frequency sweep unit, a vibration meter, and automatic level control, and an automatic displacement acceleration transfer unit.

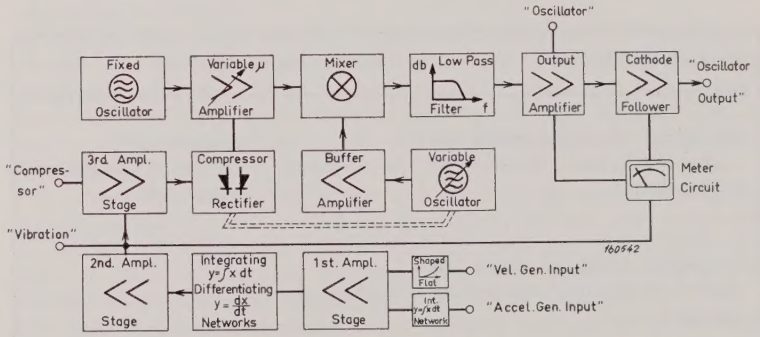


Fig. 1. Block diagram of the Automatic Vibration Exciter Control Type 1018.

The oscillator is a beat frequency oscillator, working on the heterodyne principle, with a total frequency range from 5 to 10ooo cps. The frequency range is devided into two parts, one from 5 to 5ooo cps with a true logarithmic scale, and an additional range from 5 to 10 kcps, which is switched in manually.

The frequency sweep unit features, a built-in reversible motor, for automatic frequency scanning. The frequency range 5 to 5ooo cps as well as the range 5 to 10 kcps, or any pre-determined part of these ranges are automatically scanned at a speed which is variable in steps from 3.1 degrees per minute to 315 degrees per minute, (1 frequency decade equals 72 degrees). When the pre-set frequency limits of the scanning range are reached, the motor is automatically reversed, thus traversing, the same frequency range with the same speed, but in the opposite direction.

Controls and Terminals

"Power" toggle switch controlling the on-off switching of the mains.

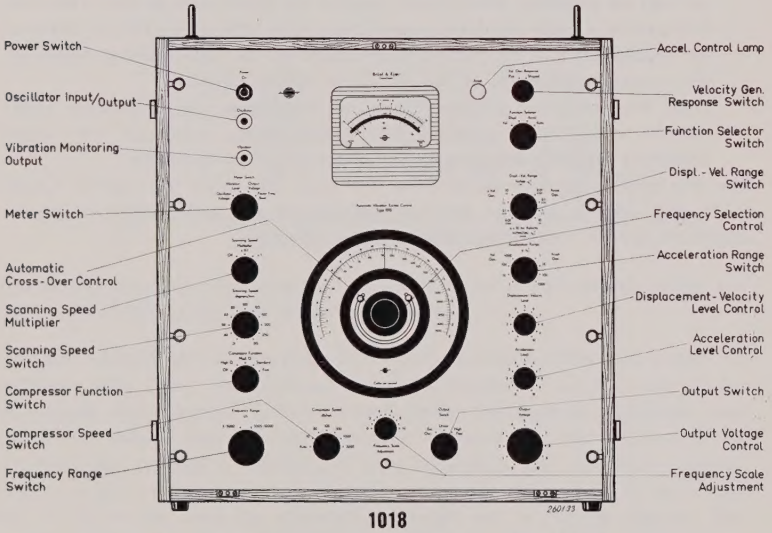


Fig. 2. Front panel control knobs and terminals.

"Oscillator" telephone jack terminal, for connecting a stroboscope to detect resonance points on the specimen, checking of the oscillator wave form, or monitoring the voltage. With the "Output Switch", Fig. 2, in position "Ex. Oscillator" a tape recorder or an external oscillator can be connected to the cathode-follower output stage of the instrument. The input impedance of the "Oscillator" terminals is 100 kΩ.

"Vibration" telephone jack terminal for checking and monitoring the vibration level, e. g. by means of a cathode-ray oscilloscope.

"Meter Switch" connects the instrument meter in a manner to show either the "Oscillator Voltage", the "Vibration Level" or the "Output Voltage", see Fig. 1. A further position of the switch is marked "Power Freq-Beat" and used during calibration of the frequency scale.

of the knob marked "Compressor Speed db/sec" on the instrument front panel. A further position of this knob is marked "Auto". With the knob in this position the *regulation speed is automatically increased with the increase in frequency,* the rate of change of the regulation speed being determined by the position of the "Compressor Function" knob. An automatic increase of regulation speed with frequency, is desirable, for the following reason:—

In order to prevent undesired level changes to build up during the frequency sweep of the oscillator the regulation speed should be kept as high as possible. However, it has to be noted that at low vibration frequencies a high regulation speed results in interacting effects between the regulation and the actual wave shape of the signal being regulated, thus causing distortion of the oscillator output signal.

With the automatic compressor speed regulation, any frequency range can be swept at a constant logarithmic sweep rate and low signal distortion without changing the compressor speed manually.

The maximum output available from the Type 1018 is 10 volts across a load of 10 kΩ. This is suitable for the majority of the many different power amplifiers used in connection with vibration exciters.

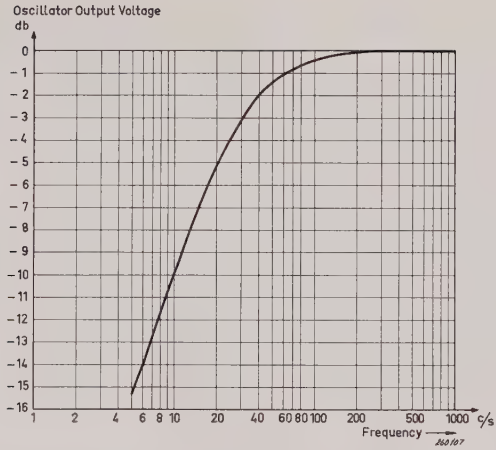


Fig. 3. Typical frequency characteristic of the high pass filter in the Oscillator output circuit.

The screwdriver operated control is used for coarse adjustment, while the knob control allows the fine adjustment of the scale.

"Output Switch" allows selection of output facilities. With the switch in position "Ext. Osc." the terminal marked "Oscillator" at the top of the instrument front panel is disconnected from the built-in oscillator, and allows the output stage of the Automatic Vibration Exciter Control to be fed from an external oscillator (or tape recorder). The frequency characteristic of the output cathode follower is linear to within 1 db in the range 0.5 — 20000 cps, and the attenuation at 500 cps is 0.5 db approx. The output voltage can be read off the instrument meter when the "Meter Switch" is in position "Output Voltage".
If the switch is set to position "Linear" the output stage has a linear frequency characteristic and is connected to the built-in oscillator.
In position "High Pass" the output stage is connected to the built-in oscillator, the frequency characteristic of the stage, however, being changed according to the curve shown in Fig. 3.

"Output Voltage" potentiometer controls the maximum available output voltage. The actual output voltage can be read on the instrument meter when the "Meter Switch" is in position "Output Voltage". During tests where the vibration level is controlled by means of the compressor circuit the "Output Voltage" should be set to a position which ensures that the "Oscillator Voltage" never exceeds 10 V. ("Meter Switch" in position "Oscillator Voltage").

"Scanning Speed Multiplier" switch controls the on-off switching of the motor drive for the automatic frequency sweep. It also allows the sweep to take place at a ten times lower speed than indicated, by the position of the "Scanning Speed — degrees/min" switch.

"Scanning Speed — degrees/min." switch contains 11 positions, and controls in conjunction with the "Scanning Speed Multiplier" switch, the frequency sweep speed.

"Compressor Function" switch controls the function of the automatic compressor when the "Compressor Speed" switch is in position "Auto".
The proper setting of the switch depends upon the frequency sweep speed required by the various vibration test specification, and the expected magnification factors, Q, of the specimen resonances.

When the switch is in position "Standard" the compressor speed will automatically increase with frequency so that the distortion of the output signal is less than 1 % for frequencies above 10 cps. The increase in speed takes place in steps:—

from	5	to	30 cps	the compressor speed will be	10 db/sec.
from	30	to	100 cps	the compressor speed will be	30 db/sec.
from	100	to	300 cps	the compressor speed will be	100 db/sec.
from	300	to	1ooo cps	the compressor speed will be	300 db/sec.
from	1ooo	to	3ooo cps	the compressor speed will be	1ooo db/sec.
from	3ooo	to	5ooo cps	the compressor speed will be	3ooo db/sec.

With the switch in position "Fast" the compressor speeds given above should be multiplied by 3, the maximum distortion of the output signal then being in the order of 2 %.

If the switch is set to "Med. Q" a compressor speed of 10 db/sec. will be maintained up to 100 cps. It then changes to 30 db/sec., which is kept until the generator output frequency is 300 cps, etc.
Position "High Q" ensures the 10 db/sec. speed to be maintained up to 300 cps, 30 db/sec. to 1ooo cps, etc.

"Frequency Range" switch allows the choice of two frequency ranges namely 5—5ooo cps (normal frequency range of the generator — in this range the frequency sweep is true logarithmic), and 5005 to 10ooo cps (additional frequency range — sweep is not logarithmic).

"Compressor Speed db/sec." switch controls the compressor speed manually in 6 steps, i. e. a fixed compressor speed of 10, 30, 100, 300, 1ooo or 3ooo db/sec. can be freely chosen. When the switch is in position "Auto" the actual compressor speed will depend upon the generator output frequency and the position of the knob "Compressor Function".

"Frequency Scale Adjustment" controls are used for correct adjustment of the frequency scale.

level is controlled. Both an accelerometer and a velocity pick-up can be used as the controlling element.

If the "Function Selector" is in position "Auto" the displacement level of the exciter is controlled below a pre-set cross-over frequency (adjustable by means of the outer knob on the tuning capacitor spindle) above which the acceleration level is controlled. The cross-over is indicated by means of the white lamp marked "Accel.", which will light whenever the instrument is switched to control the acceleration level of the vibration exciter.

"Vel. Gen. Response" switch is introduced to enable high frequency compensation of velocity type vibration pick-ups.

With the switch in position "Shaped" the compensation network is connected in the input circuit of the vibration meter amplifier, the frequency characteristic of which then corresponds to the curve shown in Fig. 4.

When the switch is set to position "Flat" the frequency response is flat from 5 cps to 2000 cps.

"Accel." lamp indicates when the instrument is switched for acceleration level control.

"Vel. Gen. Input" is a three-poled Cannon receptacle for connection of a velocity type control pick-up (or signal generator coil). Input impedance: Approximately 200 kΩ. Max. allowable vel. gen. impedance is 2000 Ω.

"Accel. Gen. Input" is similar to "Vel. Gen. Input", but should be used when the controlling element consists of an accelerometer with associated cathode follower. Input impedance: Approximately 80 kΩ.

Maximum allowable output impedance from the cathode follower is 1500 Ω.

"Oscillator Output" is a four-poled Cannon receptacle. The output should not be loaded by impedances smaller than 10000 Ω.

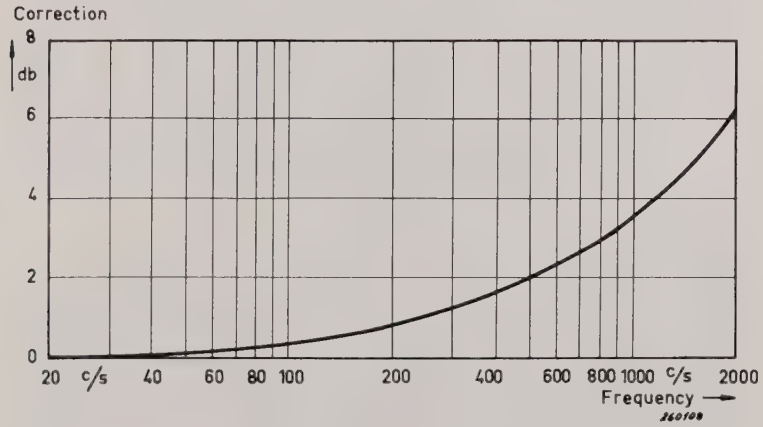


Fig. 4. Typical compensation characteristic.

"Acceleration Level" potentiometer controls the acceleration level of the vibration exciter in conjunction with the "Function Selector" and the "Acceleration Range" switches. The level can be read off the instrument meter when the "Meter Switch" is in position "Vibration Level".

"Displacement-Velocity Level" potentiometer controls the displacement level or the velocity level of the vibration exciter, the type of control being dependent upon the positions of the "Function Selector" and "Displacement — Velocity Range" switches. With the "Meter Switch" in position "Vibration Level" the actual vibration level can be read off the instrument meter.

"Acceleration Range" switch allows the selection of a number of acceleration level ranges which can be controlled by the Automatic Exciter Control. It also selects what type of feedback signal should be used for the control, i. e. whether the feedback control signal consists of the output from an accelerometer, or the output from a velocity type pick-up, such as the signal generator coil.
The markings on the left-hand side of the switch are valid, if a velocity generator is used as the controlling element, while the markings on the right-hand side are valid for accelerometer control.

"Displacement — Velocity Range" switch has two functions, depending upon the position of the "Function Selector":—

1. With the "Function Selector" switch in position Displ. the displacement level of the shaker table is controlled. The control signal can consist of the output from a velocity generator (signal generator coil), or the output from an accelerometer. The markings on the left-hand side of the Switch are valid for velocity generator control, while the markings on the right-hand side are valid for accelerometer control.
2. With the "Function Selector" switch in position "Vel." the velocity level of the shaker table is controlled. Velocity level control can only be obtained by means of a velocity type feedback signal, consequently, only the left-hand side markings can be used. However, the markings are valid for displacement control, and to read the velocity level directly, they should be multiplied by 10.

"Function Selector" switch selects the type of regulation which the instrument will perform.
With the switch in position "Vel." the velocity level of the vibration exciter is controlled. This type of regulation can take place only when the output from a velocity type pick-up is fed to the "Vel Gen. Input" terminal on the rear of the instrument.
When the switch is in position "Displ." the displacement level of the vibration exciter is controlled, and in position "Accel." the acceleration

Operation

General.

The Automatic Vibration Exciter Control Type 1018 is specially designed to be controlled directly from a velocity type of vibration pick-up having a sensitivity of 96.3 mV sec/inch, or from an accelerometer with associated cathode follower the sensitivity of which should be 10 mV/g, (both sensitivities are specified in peak voltage and peak vibration units), or a combination of both the above mentioned types of pick-up. Using pick-ups

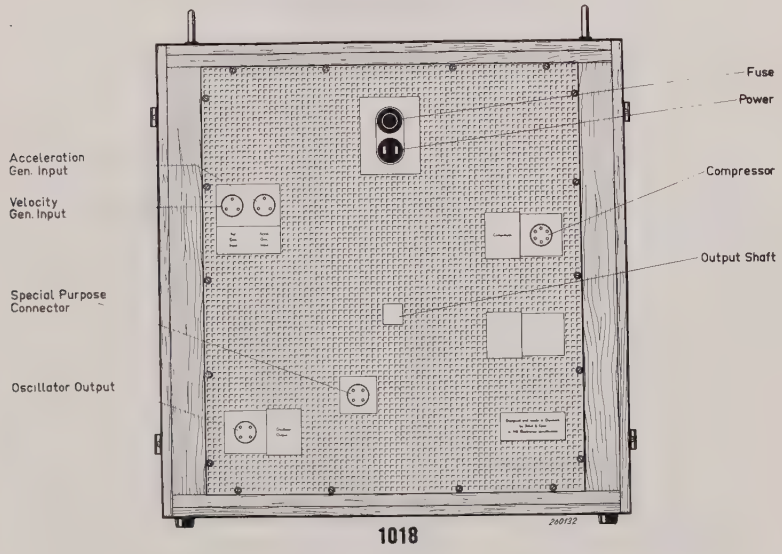


Fig. 5. Terminals and mechanical outputs from the rear of the 1018.

with the sensitivities specified, the meter provides direct readings on the acceleration, displacement, or velocity scales. However, if an accelerometer and cathode follower combination is used with a sensitivity other than 10 mV/g, it is necessary to use a capacitor output standardizer, with the accelerometer, or to vary the cathode follower output to achieve the required sensitivity.

"Compressor" is a six-poled Cannon receptacle. It makes possible the insertion of inverse shaping networks, in the compressor circuit, which may shape the vibration level/frequency characteristic according to some particular vibration test specifications. During "normal" operation of the instrument the pins 1 and 5 as well as 2 and 3 should be short-circuited, This is automatically taken care of when the special "blind" plug, which is supplied with the instrument upon delivery, is inserted in the socket.

"Output Shaft" allows the mechanical connection of an X-Y recorder potentiometer. The potentiometer may also be substituted by a ¼″ extension shaft which can be used to control other external equipment, as a function of the frequency variation of the Oscillator.

"Special Purpose Connector" is a four-poled Cannon receptacle for connection from the above mentioned potentiometer to an X-Y recorder.

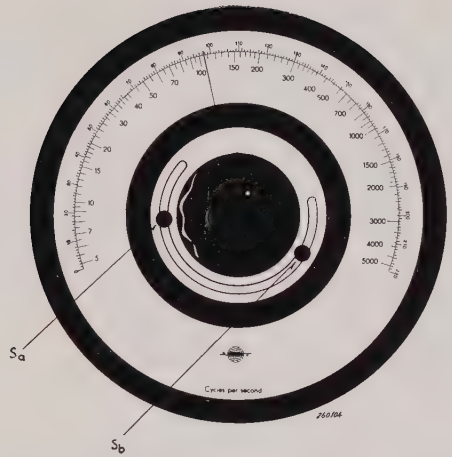


Fig. 6. Frequency Dial of Type 1018.

the screw S_a counter-clockwise until it is stopped by the contact arm of the microswitch. Fasten S_a in this position.

3. Turn the "Oscillator Frequency Dial" clockwise until the pointer points at the highest frequency at which measurements are to be taken. Then move the screw S_b clockwise until it is stopped by the contact arm of the microswitch. Fasten S_b in this position.

4. Set the "Scanning Speed" knob to the desired value, and switch on the frequency sweep by turning the "Scanning Speed Multiplier" to "x1" (or "x0.1", depending upon the speed chosen for the sweep).

The selected frequency range will now be swept automatically. When the preset limits of the range are reached, the rotation of the motor is reversed and the same frequency range will be traversed with the same speed, but in the opposite direction.

The correct setting of the "Scanning Speed" knob is easily calculated: If it is desired to scan the frequency range $f_1 — f_2 — f_1$ in T minutes the settings of the "Scanning Speed" knob is found from

$$S = \frac{2\ (d_2 — d_1)}{T}$$

where d_2 and d_1 are the degrees corresponding to the frequencies f_2 and f_1, respectively. These values can be read directly off the frequency dial. In other words, the scanning speed is the total scanning range in degrees divided by the desired scanning time.

Note: Make sure that the voltage adjuster at the rear of the instrument is set to the value of the line voltage.

Calibration of the Frequency Scale.

1. For control knob identification see Fig. 2. Make sure that the shaker is not energized during calibration, e. g. by turning "Output Voltage" to 0.
2. Connect the instrument to the power supply, set the toggle switch marked "Power" to "On" and allow two minutes warm-up time.
3. Set "Meter Switch" in position "Power Freq-Beat".
4. Set the "Scanning Speed Multiplier" in position "Off".
5. Set the knob marked "Frequency Range" to "5—5000 c/s".
6. Set "Compressor Function" switch on "Off".
7. Set "Output Switch" to "Linear" (or "High Pass").
8. Turn the "Oscillator Frequency Dial" so that the pointer points at the frequency equal to that of the line voltage. The instrument meter pointer will now start fluctuating.
9. Turn the "Frequency Scale Adjustment" knob until the fluctuations on the meter become slower and finally almost crease. The fluctuations begin again when the critical point is passed. If the adjustment knob does not give a satisfactory regulation, the screwdriver operated capacitor below the knob should be adjusted.
10. Set the frequency dial pointer to a frequency equal to ⅓ of the mains voltage frequency and repeat item 9.

The instrument is now ready for use.

Oscillator frequency checks and adjustments can be made even when the complete vibration test arrangement is operating. The "Scanning Speed Multiplier" should then be set to "Off" and the frequency dial pointer to the frequency of the mains. The procedure is then the same as outlined above in item 3, 8 and 9.

Note: To carry out the check during operation the voltage measured on the instrument meter at the frequencies used for calibration must be greater than 1 V with the "Meter Switch" in position "Oscillator Voltage".

Adjustment of the Automatic Frequency Scanning Arrangement.

1. Loosen the screws on the "Oscillator Frequency Dial" marked S_a and S_b on Fig. 6.
2. Turn the "Oscillator Frequency Dial" pointer to the low frequency limit of the range in which it is desired to take measurements, and move

(b) If it is desired to use *one* regulation speed only, throughout the frequency sweep, the speed should be chosen with regard to the distortion at the lowest test frequency. Recommended combinations based on a maximum distortion of 1 % are:—

Lowest Frequency of the Desired Sweep Range:	"Compressor Speed" Knob Setting:
Lower than 30 c/c	10 db/sec.
Above 30 c/s	30 db/sec.
» 100 c/s	100 db/sec.
» 300 c/s	300 db/sec.
» 1ooo c/s	1ooo db/sec.
» 3ooo c/s	3ooo db/sec.

The "Compressor Function" switch should in this case be set to any position except "Off".

9. Set "Output Switch" to "High Pass".
10. Set "Vel. Gen. Response" to "Flat". (Se also "Vel. Gen. Response" p. 12).
11. Set "Function Selector" to "Displ.".
12. Set "Displacement-Velocity Range" to the desired displacement level range. (If an accelerometer is used as the controlling element use the ranges to the right marked "Accel. Gen.". If the vibration level is controlled by means of a velocity pick-up, the ranges to the left marked "Vel. Gen." should be used).
    Note: The figures "0.01", "0.1", "1", and "10" indicate full scale meter deflection peak-to-peak displacement level in inches.
13. Turn the "Output Voltage" knob slowly clockwise until the compressor has taken over the control of the output voltage. (This can be observed on the instrument meter, the pointer of which should be kept below the 5 db mark on the lower meter scale).
14. Turn the knob marked "Displacement-Velocity Level" clockwise, until the instrument meter pointer indicates the desired vibration level.
15. Set "Meter Switch" in position "Oscillator Voltage".
16. Adjust the "Output Voltage" potentiometer so that the maximum output voltage required from the Oscillator during a complete frequency sweep is 10 Volts. (The scanning of the desired frequency range should be carried out manually and very slowly).
17. Set "Meter Switch" in position "Vibration Level".

The instrument is now ready for use, and the vibration test can be started by setting the "Scanning Speed Multiplier" switch to the desired position.

Operation at Constant Displacement Level.

This type of operation can be achieved by using either an accelerometer or a velocity type pick-up as the controlling element of the shaker table motion.

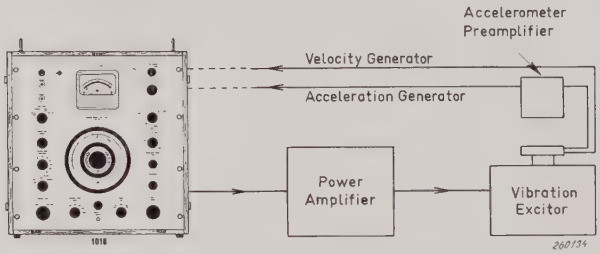


Fig. 7. Typical vibration test arrangement.

Level Range	With Accelerometer	With Velocity Pick-up
10″	5— 500 c/s	5— 500 c/s
1″	5— 500 c/s	5— 500 c/s
0.1″	5—2000 c/s	5—2000 c/s
0.01″	50—2000 c/s	5—2000 c/s

To set up the test apply the following procedure:—

1. Set the knob marked "Output Voltage" to "0".
2. Calibrate the instrument as described under "Calibration of the Frequency Scale", page 15.
3. Adjust the automatic frequency scanning arrangement, page 16.
4. Turn the knobs marked "Displacement-Velocity Level" and "Acceleration Level" to "0".
5. Connect the instrument as shown in Fig. 7.
6. Set "Meter Switch" in position "Vibration Level".
7. Set "Scanning Speed Multiplier" to "Off".
8. Adjust the regulation speed as follows:—
   (a) If it is desired to automatically obtain the highest permissible regulation speed as a function of frequency the "Compressor Speed" knob is set to "Auto". The setting of the "Compressor Function" switch will then depend upon the specimen Q and the speed required for the frequency sweep of the oscillator.

3. Set "Acceleration Range" to the desired acceleration range using the proper part of the switch ("Accel. Gen." or "Vel. Gen.").
   Note: The figures "1", "10", "100", and "1000" indicate full-scale meter deflection peak value acceleration levels in multiples of G.
4. Turn the "Output Voltage" knob slowly clockwise until the compressor has taken over the control of the output voltage. (This can be observed on the instrument meter, the pointer of which should be kept below the 5 db mark on the scale).
5. Turn the knob marked "Acceleration Level" clockwise until the instrument meter pointer indicates the desired vibration level.
6. Follow instructions item 16 through 18 under "Operation at Constant Displacement Level". (Page 18).

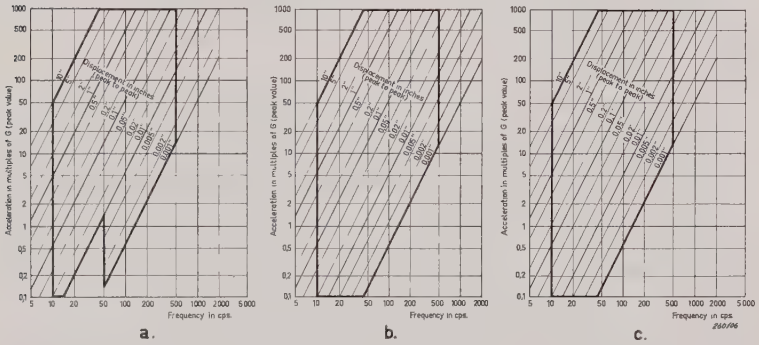


Fig. 8. Diagrams showing the possible cross-over points as a function of frequency. All values within the thick lines can be used.

Operation at Constant Displacement / Constant Acceleration Level.

This type of operation can be obtained by using either an accelerometer or a velocity type pick-up, or both, as the controlling element.

The frequency and level ranges available, when the different types of control are used are best illustrated by means of three diagrams, see Fig. 8.

Fig. 8a shows the frequency and level ranges which can be utilized when an accelerometer is used as the controlling element only.

Fig. 8b shows how the ranges are slightly changed when a velocity type pick-up is used to control the table motion.

Fig. 8c shows the operating ranges when a velocity type pick-up is used for displacement control (i. e. below the cross-over frequency), and an accelerometer is used for acceleration control (i. e. above the cross-over frequency).

To set up the test the following procedure may be applied:—

When the test is over, the instrumentation should be *switched off by first turning the "Output Voltage" knob to "0"* and then disconnecting the power amplifier, the Exciter Control and the field coil supply from the mains by means of their various "On-Off" switches.

Operation at Constant Velocity Level.

Constant velocity level control is only possible by means of a velocity type pick-up. The frequency range available for velocity level control is 5—2000 cps, and the level ranges are 0.1 inch/sec., 1 inch/sec., 10 inch/sec., and 100 inch/sec. The various ranges are found by multiplying the numbers on the left-hand side of the "Displacement-Velocity Range" switch by ten).

To set up the test apply the following procedure:—

1. Follow instructions item 1 through 11 under "Operation at Constant Displacement Level". (Page 17).
2. Set "Function Selector" to "Vel.".
3. Set "Displacement-Velocity Range" to the desired velocity level range. (The actual velocity level range corresponds to the numbers marked on the left-hand side of the knob when multiplied by ten).
   Note: The level ranges 0.1 inch/sec., 1 inch/sec., 10 inch/sec., and 100 inch/sec. indicate full-scale meter deflection peak value velocity.
4. Follow the instructions item 14 through 18 under "Operation at Constant Displacement Level", page 18.

Operation at Constant Acceleration Level.

Constant acceleration level operation can be obtained by using either an accelerometer or a velocity type pick-up as the controlling element. The available frequency and level ranges are:—

Level Ranges	With Accelerometer Control	With Velocity Pick-up Control
1—10—100 and 1000 G*)	10—10000 cps	10—2000 cps

G*) = acceleration of gravity (981 cm/sec.^{2} or 386 inch/sec.^{2}).

To set up the test, apply the following procedure:—

1. Follow instructions item 1 through 10 under "Operation at Constant Displacement Level". Page 17.
2. Set "Function Selector" to "Accel.".

Appendix

Use of Type 1018 as Vibration Meter only.

The Automatic Vibration Exciter Control can be used as a vibration meter when the "Compressor Function" switch is set to "Off". However, to obtain a correct reading on the instrument meter the "Displacement-Velocity Level" and "Acceleration Level" potentiometers should then be set to "10".

If it is desired to monitor the vibration level, this can be done by connecting an AC level recorder to the terminal marked "Vibration" on the front panel. Due to the relatively high output impedance the load impedance should not be less than 100 kohms.

Some Notes Regarding Cycling Systems Operation.

If a cycling system is used together with a shaker (and power amplifier) which contains no overdriving protection circuits, damage might under certain circumstances occur to the shaker. Two examples of damage-producing operations are mentioned in the following:—

When specimens with very high Q resonances are tested outside the normal operating range of the shaker, the compressor arrangement may not be able to maintain a constant vibration level on the shaker table due to overdriving in the power amplifier. This again will result in overdriving of one or more of the oscillator and amplifier stages. The situation can be observed on the vibration meter, the indication of which will decrease instead of keeping a fixed value. If now the "Meter Switch" on the 1018 is switched from its position "Vibration Level" to "Oscillator Voltage", i. e. if the operator wants to check the oscillator voltage, the feedback in the oscillator output circuit will suddenly change, correspondingly changing the overdrive level. The change introduces a DC component in the shaker drive voltage, causing the shaker to "jump", which will eventually produce damage.

A similar situation is created if the "Output Voltage" potentiometer of the Vibration Exciter Control is turned quickly down during the above described operating conditions.

However, not all types of "unusual" effects will produce damage. For example, during automatic cross-over operation a sudden increase in the deflection of the vibration meter may be observed at the moment when the crossing-over takes place. This may mislead the operator to assume that the vibration level of the shaker has suddenly increased. This effect is due to an electrical transient in the first stages of the regulating amplifier and does not normally influence the actual vibration level of the shaker, due to the

1. Follow instructions item 1 through 10 under "Operation at Constant Displacement Level", page 17.
2. Set "Function Selector" to "Auto".
3. Set the Oscillator frequency dial pointer to the desired cross-over frequency.
4. Keep the dial pointer in its position, i. e. pointing exactly at the desired cross-over frequency, and turn the outer knob on the tuning capacitor shaft, until the lamp marked "Accel." at the top left on the instrument front panel just cuts in (or out).
5. Set the frequency dial pointer to a frequency *just below cross-over,* i. e. where the "Accel." lamp cuts out.
6. Set the "Acceleration Range" switch to the proper acceleration range, see also Fig. 8.
7. Proceed as outlined under "Operation at Constant Displacement Level", item 12 through 15.
8. Adjust the "Output Voltage" potentiometer until instrument meter pointer shows a suitable deflection, for example 10 db (lower meter scale).
9. Set the frequency dial pointer to a frequency *just above cross-over,* i. e where the "Accel." lamp cuts in.
10. Turn the knob marked "Acceleration Level" clockwise until the instrument meter pointer deflects to the same value as in item 7 (10 db on lower meter scale).
11. Re-adjust the "Output Voltage" potentiometer so that the maximum oscillator voltage required during a complete frequency sweep is 10 V. (The scanning of the desired frequency range should be carried out manually and very slowly).
12. Set "Meter Switch" to "Vibration Level".

The instrument is now ready for use and the vibration test can be started by setting the "Scanning Speed Multiplier" switch to the desired position ("× 0.1" or "× 1").

When the test is over, the instrumentation should be *switched off by first turning the "Output Voltage" knob to "0"* and then disconnecting the power amplifier, the Exciter Control and the DC power supply, from the mains by means of their various "On-Off" switches.

Specifications

OSCILLATOR SECTION

Frequency Range: 5—5000 c/s and 5—10 kc/s.

Frequency Scale: Logarithmic from 5—5000 c/s.

Frequency Accuracy: 1 % ± 0.25 c/s.

Output Voltage: Max. 10 volts.

Max. Load: 10 kΩ.

Output Voltage Accuracy: Better than ± 0.5 decibel in the frequency range 5—5000 c/s and better than ± 1 decibel for frequencies between 5 and 10000 c/s.

Waveform: Maximum distortion in the frequency range 5—10000 c/s, 0.5 % without compressor. Maximum distortion with compressor 0.5 % for higher frequencies, and 1 % for 10 c/s at the lowest compressor speed.

Hum Voltage: At least 65 decibels below full output.

Scanning Speed: Variable in 22 steps from 3.1 to 315 degrees per minute.

Frequency Limit Controls: Front panel set-screw adjustment.

Automatic Cross-over Control: Cross-over frequency may be adjusted over the frequency range 10—500 c/s.

VIBRATION METER SECTION

1. Velocity Pick-up as Controlling Element.

Displacement Ranges: Full scale readings 0.01″ (0.025 cm), 0.1″ (0.25 cm) 1″ (2.5 cm), and 10″ (25 cm), peak-to-peak value. Accuracy ± 4 % from 10—2000 c/s. Approximately 4 % down at 5 c/s.

rather large time constants of the compressor circuit. However, if the crossing-over takes place at a very high or a very low frequency, the drive to the shaker may suddenly decrease and then slowly increase again until the normal drive level is regained.

Another effect which may be mentioned is the instability occurring when too high compressor speeds are employed and the test specimen contains high Q resonances. These can be readily cured by choosing a lower compressor speed and the corresponding lower sweep speed.

Notes on Using an Accelerometer as Controlling Element for the 1018 Vibration Exciter Control.

At low frequencies and low shaker displacement levels the acceleration level will be extremely low. (The acceleration level with a peak-to-peak table displacement of 0.1″ at 5 c/s is for example only 0.13 G. G = acceleration of gravity = 386 inch/sec.^{2}). It is therefore necessary to take special precautions when an accelerometer is used to control low frequency shaker displacement levels within the 1018 level ranges 0.1″ and 0.01″.

(a) It is recommended to use accelerometers with relatively high charge-sensitivity, i. e. the product of accelerometer voltage sensitivity (mV/G) and internal capacity ($\mu\mu$F) should be as high as possible, preferably higher than 30 $\mu\mu$ columb/G.

(b) In most cases it will be necessary to mechanically shield the accelerometer against the surrounding air, for even slight air motion ("wind") around the pick-up causes relatively great electrical noise in the accelerometer output signal.

(c) The accelerometer preamplifier must be of a very high quality, preferably supplied with a sharp cut-off filters which attenuates frequencies outside the operating range of the 1018. A very heavy stabilization and smoothing of the plate as well as the filament voltages are normally required to avoid low frequency disturbance signals from the power supply, such as DC variations, which upset the proper functioning of the amplifier (maximum allowable disturbance signal level is 10 μV). In some cases it may, in addition to the stabilization, be advantageous to reduce the filament voltage by approximately 10 %.

Great care has also been taken in the design of the 1018 Automatic Vibration Exciter Control to diminish the effects of low frequency disturbances, and a sharp cut-off filter has therefore been incorporated in the vibration meter section. The cut-off frequency of the filter is 5 c/s.

as a function of the oscillator frequency. "Switching" frequencies are:— 30—100—300—1ooo and 3ooo c/s.

Dynamic Range: 45 db. 20 db can be compressed to o.5 db and 40 db can be compressed to 1.5 db.

Power Supply: 115—127—150—220 and 240 Volts (± 10 %). 50 c/s or 60 c/s (specify when ordering).

Tubes: 1 × 6AU6 (EF94) — 4 × 12AT7 (ECC81) — 1 × 12AU7 (ECC83) — 1 × 6BL8 (ECF80) — 1 × 6U8 (ECF82) — 1 × 6AL5 (EAA91) — 1 × 12BY7 — 1 × 6CA4 (EZ81) — 1 × OA2 — 1 × OB2.

The Automatic Vibration Exciter Control can also be delivered in a steel cabinet with flange for 19″ rack mounting as Type 1038.

Dimensions:	Type 1018	Type 1038
Depth	34 cm (13.5 inches)	28 cm (11 inches)
Height	52 cm (20.5 inches)	48.5 cm (19$\frac{7}{32}$ inches)
Width	51 cm (20 inches)	48 cm (19 inches)

Weight: 30 kg (63 lbs.).

Acceleration Ranges: Full scale readings 1 g, 10 g, 100 g, and 1ooo g (peak value). Accuracy ± 4 % from 10—2ooo c/s.

Velocity Ranges: Full scale readings o.1 in./sec. (o.25 cm/sec.), 10 in/sec. (25 cm/sec.), and 100 in./sec. (250 cm/sec.), peak value. Accuracy ± 4 % from 5—2ooo c/s.

Pick-up Sensitivity: The vibration meter is adjusted for a velocity pick-up output of 96.3 mV sec. per inch. (Peak-value volts and peak-value velocity)

Pick-up Impedance: Maximum 2 kΩ.

Input Impedance: Approximately 200 kΩ.

2. Accelerometer with Cathode Follower as Controlling Element.

Displacement Ranges: o.01″ (o.025 cm), peak-to-peak value. ± 4 % from 100 c/s to 2ooo c/s. Approximately 4 % down at 50 c/s.
o.1″ (o.25 cm), 1″ (2.5 cm), and 10″ (25 cm), peak-to-peak value, ± 4 % from 10—2ooo c/s. Approximately 4 % down at 5 c/s.

Acceleration Ranges: Full scale readings 1 g, 10 g, 100 g, and 1ooo g (peak value). Accuracy ± 4 % from 10—10ooo c/s.

Pick-up Sensitivity: The vibration meter is adjusted for an accelerometer (+ cathode follower) output of 10 mV per g. (Peak-value volts and peak-value acceleration). The maximum allowable output impedance of the cathode follower is 1500 Ω.

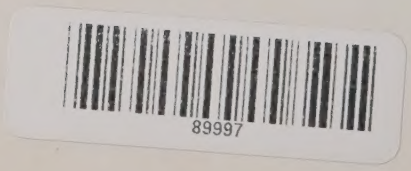
Input Impedance: Approximately 80 kΩ.

Meter Scale: Semi-logarithmic.
Gradated: 0—10 (Volts, G, inches, inches/sec.).
0—25 (cm, cm/sec.).
—10 to + 20 db (decibels).

COMPRESSOR SECTION

Frequency Range: 5—10ooo c/s.

Regulation Speeds: 10—30—100—300—1ooo and 3ooo db/sec. Can be selected manually as a fixed speed for a complete frequency sweep or automatically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Printed in Copenhagen, Denmark

July 1963